RAILWAY ENGINEERING
and Maintenance of Way

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THE recent earthquake at San Francisco has had far reaching effects. One in particular is that one on the Panama Canal question. That part of the report favoring a sea level canal is strengthened by the statement that an earthquake on the Isthmus will be much less disastrous to walls, banks, etc., with the sea level type than with the complicated lock type.

THE track elevation of the New York Central through the streets of Schenectady furnishes one of the latest and best examples of the utility of concrete in railway engineering, since the viaduct and retaining walls are of that material. These improvemets eliminate nine grade crossings, the principal one of which is State street, the main business artery of the city. This work is a stupendous one, as it embraces not only raising the tracks but also an elevation of the bridges over the Erie Canal and the Mohawk River, both of which however, have sufficient head room to enable the use of the old structures with the increased height of tracks. The advantages accruing to these improvements are twofold on the road as the grade reduction effected will make it possible for the road to discontinue the expensive pusher service which has been maintained on the Schenectady hill from time beyond the memory of the old ones, as well as to send the flyers through the city without a slow-down at crossings. While not comparable with the track elevations of steel and stone like those in Chicago which stand in a class by themselves for length and expense, and also a style of construction which would scarcely be considered at this time, this work represents the newer ideas in compassing results in track elevation.

OF GREAT interest of late in the development of schools all over the country for education in railway work. The Railway School at the University of Chicago is in its second year and is meeting with fair success. A similar school is to be established at New York by the New York University. At Altoona, the Pennsylvania Railroad has already begun active work and many others are rapidly springing up in important railroad centers. While the impossibility of the scheme as to learning "railroading" from books is readily seen, it is true that many engineers live and work in their own narrow sphere, and this is where the railway schools, if properly conducted, are of the highest benefit. If the school can take a young man and instill in him the idea of observing and studying not only his particular road but the methods as pursued by other roads and why these certain methods are used, the school has performed its duty and the young man will be the kind that is sought for to fill the higher positions.

AN engineering proposition greater than any other of the kind heretofore attempted is again being revived by the members of the London Municipal Council. This body has been in Paris studying the problem of a betterment of transportation facilities between England and France, with the view of cutting out the channel voyage of 33.5 miles, by means of tunneling under that body of water. In this connection "Le Journal des Transports" says in substance: Dread of the sea voyage is the reason why the volume of travel is light. While the total population of the Continent and British Isles is about 150,000,000 the actual annual exchange of traffic over all lines between France and England is hardly 1,200,000, and between France and Belgium, with a total population under 50,000,000, the annual exchange is nearly 4,000,000. On these grounds M. Sartiaux recommended to the London officials a project for tunneling.

The initial move for such a tunnel, made several years ago, was brought to an abrupt end by English public sentiment led by Lord Wolseley, who convinced the people that the project threatened the territorial security of England. He preferred a bridge because it could be seen. But a bridge would obstruct navigation. Later there was a plan for a combined bridge and tunnel by which about one-third of the distance on the British side was to be traversed by a bridge, and the balance by a tunnel. It is to be hoped that the representatives of Great Britain in Parliment will see more clearly today than they have in the past, the desirability of closer connection with the Continent, and that the great obstacle to communication between England and France will soon be removed.

AMONG the schemes on foot for the improvement of surburan service about New York and vicinity is that of the Monorail system from Manhattan to Coney Island. A full sized working model of this system was in operation at Coney Island for several seasons, and also on exhibit at the St. Louis Exposition. As its name implies, the cars are suspended on a single rail which is supported on a steel frame work of such a height as to give ample clearance at the ground line. As suspended from the rail, the center of gravity is below the point of suspension, making the car pleasantly devoid of the oscillations experienced on surface roads, and should therefore be safe on curves at high speed.

"Disintegrated Granite" Ballast

IT is with a great deal of satisfaction that several of the western roads can point to their experimental work with "Disintegrated Granite" ballast. On the Union Pacific the material is taken out by steam shovel from Sherman Hill, located between Cheyenne and Laramie, Wyoming. Its use has met with sufficient success to involved almost the entire line from Ogden, Utah, to Omaha, Neb. Besides forming a most excellent ballast for tracks the continued cutting has greatly reduced the cost of operating trains over Sherman Hill. The Colorado Division of the Rock Island has been using this material since 1903 and finds it to be highly satisfactory. Their first use of the disintegrated or decomposed granite was made in that year from the Cripple Creek Short Line. At present they are getting the material from Apel, Colorado, on the Colorado Midland Ry. There is a slight difference in the color and size of the pebbles or stones composing the make up of the two. That from the Short Line has a pinkish cast and the pebbles are rather fine while that from the Midland though having a general pinkish color has a slight grayish cast and the stones are slightly arger. As regards the drainage and firm bearing for the tracks it is claimed to be considerably better than ordinary gravel. It seems to combine the good qualities of stone and gravel ballast. The mention of this ballast is of course as speaking of a track luxury, for railroads are and probably will use for a good many years their own stone quarries, their own gravel pits and their own cinders.

Is Such a Union Desirable?

AN idea proposed by Mr. L. C. Fritch, assistant to the general manager of the Illinois Central, and secretary , until recently, since its birth, of the American Railway Engineering and Maintenance of Way Association, is suggestive for considerable comment. The plan is as follows and is being sent out in the shape of a pamphlet embodying the fundamental principles and a proposed constitution.

First to combine the following organizations:

American Railway Association, American Railway Engineering and Maintenance of Way Association, Master Car Builders' Association, American Railway Master Mechanics' Association.

The pamphlet gives the following statements of benefits to be derived by such a union.

"The advantages to be secured in the amalgamation of these four associations into one body are manifest, inasmuch as the object of each is directed to one purpose, and this purpose can be more economically, efficiently and readily attained if these four associations work cojointly and towards a common end.

The work of the four associations is interdependent, but as at present organized, much valuable time and effort are lost or misdirected, which under one organization will be utilized to the fullest extent and accrue to the greatest benefit of the railways.

All commercialism should be eliminated from the work of the organization devoted to the cause of railway operation, which result will be accomplished by membership restricted to transportation companies. On the other hand, all officers of railways, members of the congress, would receive the benefits of membership through the proceedings of the congress, which should be widely disseminated among the officers of the members This is not now possible under the individual memberships of some of the railway organizations, without expense to the individual.

The plan of the congress, and its adoption by the American Railways, is recommended to the officers who manage the American Railways, the sole purpose in proposing the plan being that our railway operation may be advanced along the lines of proven methods and practices, and speedily placed upon a scientific basis.

A committee on organization, composed of three members from each of the four present railway organizations, is recommended to carry out the purpose of the plan herein suggested."

In the proposed constitution there is provided as to officers a President, six Vice-Presidents, two for each of the following sections into which the Congress is to be divided

Section A—On Transportation.

Section B.—On Maintenance of Way.

Section C.—On Maintenance of Equipment.

A general secretary and treasurer and a secretary for each of the three sections, and twelve directors, four for each section is also proposed and Chicago is named as headquarters. The membership is to be of common carriers engaged in the operation of American railways, any such company having a mileage of 50 miles being eligible to one active membership, and in case of aggregate main line mileage of more than 1,000 miles, to one additional active membership for each additional 1,000 miles operated. A mileage of less than 50 miles entitles to associate membership only and does not carry the right to vote or hold office.

The constitution further provides for dues, assessments, duties of officers, etc.

The above plan which will no doubt be greatly commented upon seems to be a most excellent one. It will have the tendency to broaden the views of many merely department officers who, without the slightest disrespect, are too often liable to be narrow and become tied down to their own line. On the other hand the loss of individuality and the membership exclusive of special experts, supplymen, etc., may mean the loss of a great deal of valuable information and help and the result of the letter vote will be awaited with great interest.

Modern Railway Coal Chutes

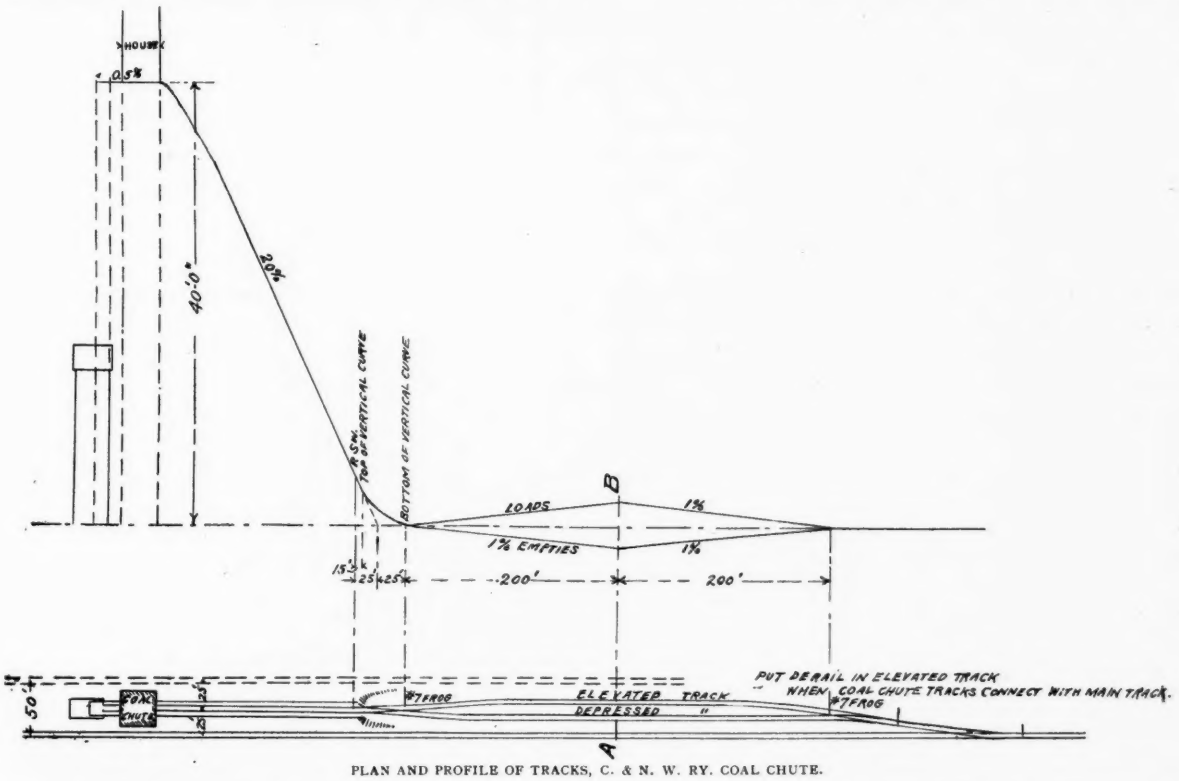
*I

THE handling of coal for engines is and probably always will be a "bugaboo" for the maintenance of way engineer. In earlier days with small engines and few of them the problem was comparatively simple. The old method of transferring by hand or shovel from a coal car or bunker direct to the tender was economical in the saving of coal itself and it might be said was adjustable to the varying heights of tender according to the strength necessary to throw the coal over the side. But as for time that was a matter not to be considered and in truth it made no difference, for then there were no competing lines to bother. If persons did not desire to ride that particular line they took the slower wagon route or stayed at home, likewise with their freight.

With the introduction of competing lines and the consequent element of time becoming important, towns beginning to grow, factories beginning to spring up in many places, larger engines and more of them had to be used. The coal chute proper has seen many ingenious improvements since the first crude form.

Among the many modern coal chutes now being installed, the type used by the Chicago and Northwestern railway will be found particularly interesting.

The long gradual trestle approach has been termed the "ideal" type, but in too many cases there is insufficient room and the sharp approach with hoisting cable serves the purpose admirably. As shown in the accompanying cuts the incline is 20%, with the direct drop from the car at the top to tender below. The under cut gate and adjustable hood regulate the placing of the coal. One great trouble has been eliminated by the use of the adjustable hood, the principle being similiar to the spout on a water column, on account of the great range of tenders from the small switch engine type to the modern "battleship." With the ordinary open apron type, there is generally a big loss of coal, for the slope that will suit the large tender will very likely shoot a good many chunks over the side of the small tender.



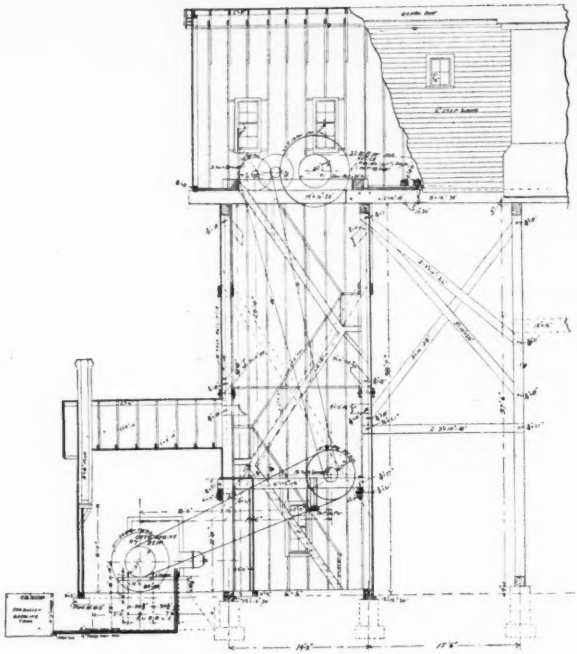
PLAN AND PROFILE OF TRACKS, C. & N. W. RY. COAL CHUTE.

In the approach to the trestle itself there are two tracks each about 400 ft. long connected at each end with a No. 7 frog and split switch, one track for loads going up the trestle and the other for empties with grades as shown. For sills, posts and caps 12 inch x 12 inch timber has been specified with 3 inch x 10 inch bracing, stringers which are four in number are 8 inch x 16 inch, one pair under each rail bolted with a ¾ inch bolt.

There is 217 ft. of the trestle approach which gains a rise of approximately 39 ft. from base of rail to base of rail. The power used in drawing the cars up by cable is through a gas engine, two types of which are proposed, one of which is of 35 horse power, the other 32.

With this type of chute the large number of pockets generally used, can be dispensed with as the under cut

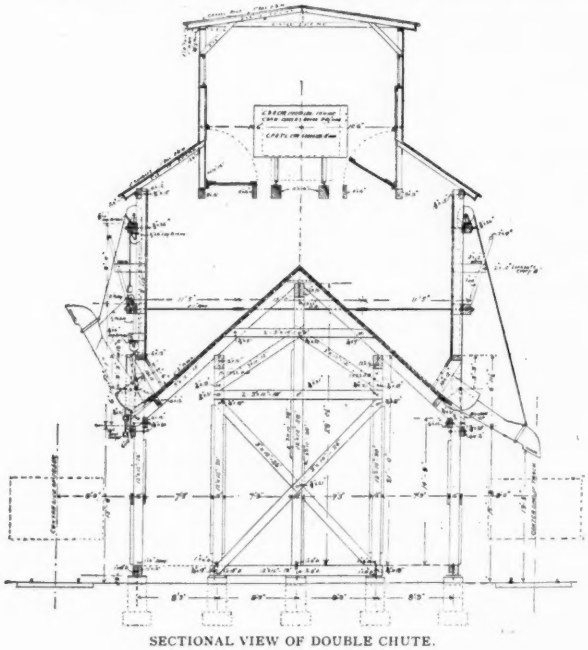
*Being the first of a series of articles on the above subject.



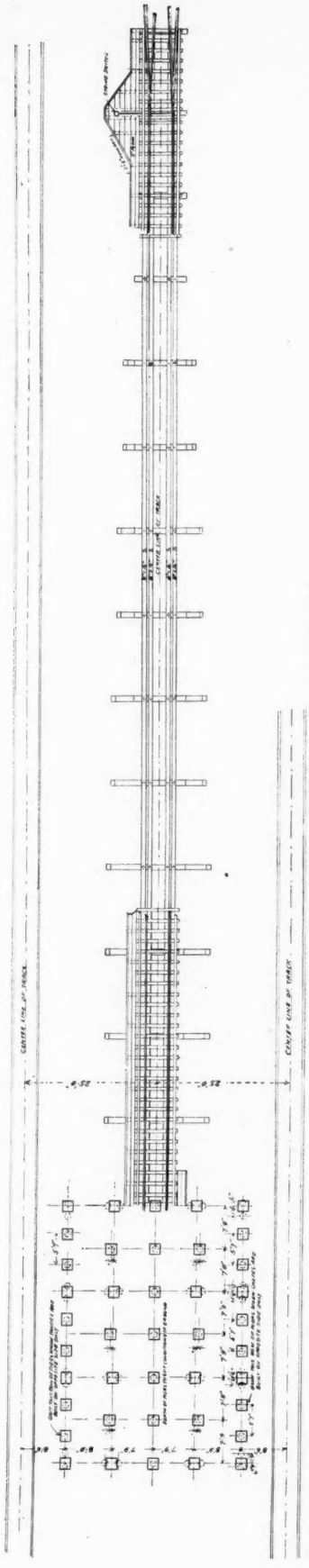
SECTIONAL VIEW OF ENGINE HOUSE.

gate and the automatic safety lock will regulate the amount of coal to be taken out. The top of the pockets are hinged and raise to a vertical position, being so placed as to give ample room to the largest coal car, which at the present time in the central west, seems to be the Chicago & Alton, 55 ton capacity car which is 10 ft. wide. In the case of the double chute the bottom is in the shape of a downwardly inclined "V," while with the single chute or where tenders are loaded from one side of the coal chute only the bottom is one single slope, the vertical drop being about 18 ft. With the double chute the long slide is broken up of course and as a result the action is not quite as good as in the case of the single chute.

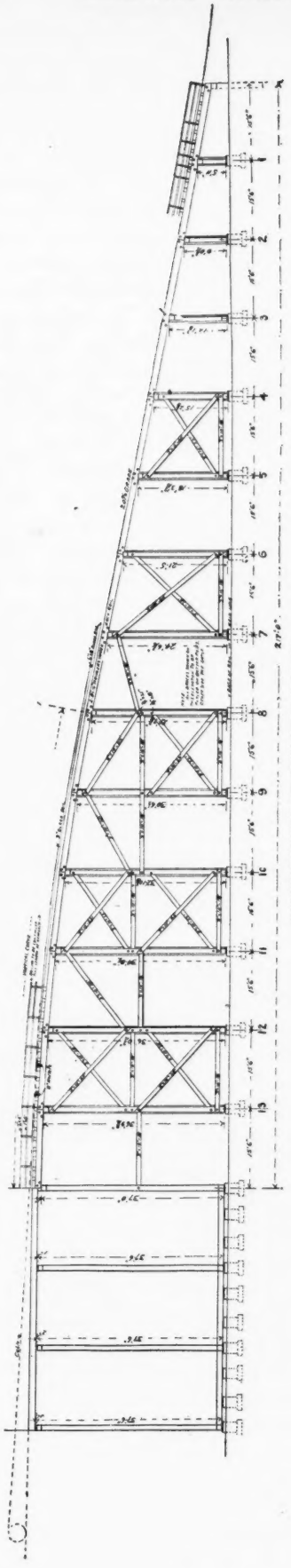
An automatic safety lock, rigged up from an 8 in.



SECTIONAL VIEW OF DOUBLE CHUTE.



PLAN OF CHUTE FOUNDATION AND TRESTLE APPROACH.



SIDE ELEVATION OF TRESTLE APPROACH.

pulley, ½ in. cable, a ¾ in. rod and an 18 lb. sash weight has been found to form a very effective but simple device for holding the door leading from the bins to the hood shut, when not in use.

The main section of the chute is placed under a roof graveled over 1 in. sheeting, while the part of the roof lying out and below the main section is shingled.

In the foundation 12 in. x 12 in. sills rest on piers 2 ft. square which in turn rest on foundations having the customary 6 in. projection.

As regards the cost of operating no figures can be given as the types described are general being taken from plans of two and three bents and both single and double pockets. However, as compared with the long approach type where the locomotive is used to push cars up, instead of the type of engine and cable as here described, there is but little difference in the cost when a general average is struck. In some particular cases the "long approach" many cost more but as a general average it is slightly under that found with the type as described. We are indebted to Mr. E. C. Carter, Chief Engineer of the Chicago & Northwestern, for drawings, etc.

Policing of Right of Way

AN IMPORTANT duty in maintenance of way matters too often neglected is the policing of the right of way. The relative importance of this work is more particularly noticeable in systems or lines paralleling each other for any appreciable distance. Keeping the right of way in good order is like keeping house, no one visiting a new house cares to see everything out of order and kept in a shabby manner and will probably keep out of the way of making another visit very soon. Just so with the passenger travel; a road well kept up speaks for itself and a small amount of expenditures in the maintenance department will work wonders in the future passenger traffic. The traveler notices the right of way much more than is generally believed, such as the odd iron and steel scrap left to lie alongside of the tracks long after the renewal in the track has been made.

This is due a good many times, it is true, to the lack of cars available for the transportation of such material or a delay in the main office for ordering the cars out. On the other hand, it is too often the fault of the roadmaster or supervisor in not noting the odds and ends scattered along the track and at once notifying the proper authorities and requesting cars for immediate removal. Again, it may be through the bridge and building department, which is a recognized department on all roads of any magnitude. In repairing metal and wooden structures, they too often leave scraps of piling, blocking, odd drift bolts, nuts, etc., laying around after they have made their renewal, depending upon the section men coming along later to clean up and make the necessary report on the scrap.

Then, too, it is wonderful what a little paint can do on the old station buildings, section houses and water tanks. A little grass plot with flowers, shrubbery or a fountain will easily attract attention and that particular passenger will tell his or her friends about how much

more pleasant a trip is on that road than others and the next time that person or the friends take a trip it is readily seen which road will receive their patronage.

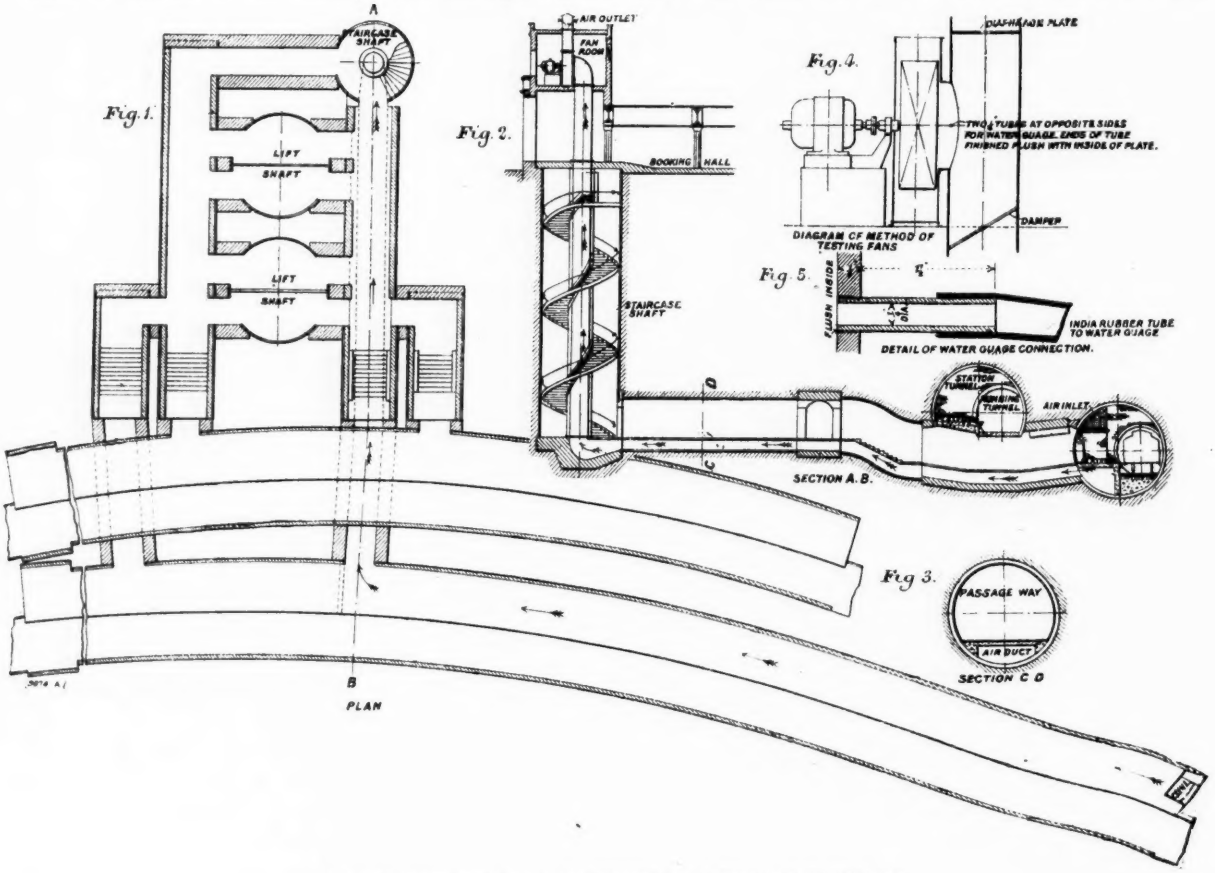
Ventilation of Baker, Street and Waterloo Railway Tube

THE increase in tunnel construction in this country to meet the growing needs of terminals as well as of interurban transportation has forced the consideration of ventilation of such work, that has heretofore been passed over as of little moment, for the reason that its importance was never understood until bores of great length were completed and in operation, when it was seen that the so-called piston action of trains failed of their purpose in many cases in the displacement of air, and all induction theories previously held were found to be erroneous. This was true in case of the London tubes and is also true in case of the New York subway. For some particulars concerning the latter see the September and October issues of Railway Engineering and Maintenance of Way.

No scientific treatment of this question had been attempted until it was approached by Mr. G. Rosenbusch, A. M. I. C. E., who has done more to clear the "atmosphere" of doubt and tunnels as well, than any one before him, and excerpts from his paper in "Engineering" of London, issue of Dec. 22, 1905, given herewith, will be found of interest in this country. His findings which, in many particulars reflect the situation here, are as follows:

"When the Central London Railway was first built, no form of mechanical ventilation was contemplated by the engineers, the form of construction and mode of operation being considered such as to sufficiently conduce to the maintenance of non-polluted air. Unfortunately, the desired results were not realized, and further means were adopted at considerable expense. Before describing these, however, it is well to remind ourselves of the form of construction and mode of operation, and also define more exactly polluted air, the Central London Railway being taken as a typical example of a tube railway.

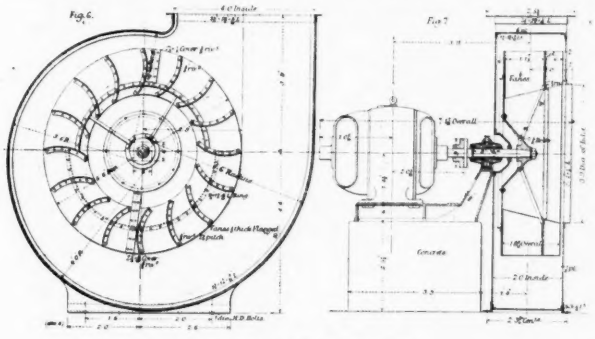
A tube railway of the recognized type consists of two circular and parallel tunnels, entirely separate except at crossovers. In each of these tunnels are run trains, unidirectional as to each tunnel, but in opposite directions relatively to each other. These trains fit the tunnel so closely as to act in the nature of air pistons, and consequently, push and pull horizontal columns of air from station to station. It was anticipated that these movements would result in an interchange with the surface air sufficient to keep the atmosphere pure enough for the average pasenger, both in the station and tunnels. The air on the City and South London Railway is undoubtedly musty and very unpleasant, showing that it is not renewed sufficiently, but, on the other hand, it is chemically well within the limits of the allowable C O2, thus



PLAN OF VENTILATION OF BAKER STREET AND WATERLOO RAILWAY TUBE

proving that it has been renewed to a considerable extent from the surface, account being taken of the fact that many C O_2 generating passengers have been carried.

Now—polluted air, from the hygienic standpoint—may be taken to mean air in which the proportion of C O_2 does not exceed the normal allowance of 13 parts in 10,000, other impurities being correspondingly normal. (Dr. J. S. Haldane)—In order to approximate to this desired result on a tube railway, several methods of pro-



DETAILS OF FAN FOR VENTILATION.

cedure are available. The most obvious method—employed by Fox on the Mersey tunnel,—is to sink shafts midway between the stations, and at these points either to exhaust air from, or supply air to the tunnels, the adjoining station shafts acting as corresponding intakes or exhaust shafts. The use of this method has to be abandoned, however, in most cases, because of the prohibitive cost of surface rights in Central London for those intermediate shafts, even ignoring the cost of building them.

On the Central London Railway, when it was found that the mechanical ventilation had to be adopted to supplement the train action—the above method being prohibitive, and the stations as designed not lending themselves (without alterations) to the introduction of ventilating apparatus—the following expedient was adopted: A large mine fan of the Guibal type was installed at the terminus at the tunnel mouth at Sheperd's Bush, and the air sucked out the entire distance from the bank, six miles. In order to accomplish this result it is necessary to close the tunnels from the surface at all intermediate stations, and to work with a high suction, to pull the air that distance in sufficient quantities. This results in a very high velocity of air, which, coupled with the fact that the surface stations must be closed from the tunnels, prevents the proper use of the fan during traffic hours, and its use is therefore confined to a very few hours every night. In other words, the attempt is made to give the tunnel every night, what Sir B. Baker termed a "spring cleaning." There is no doubt that the air is very much better than before the fan was in commission but it is noticeable that the pollution is constantly increasing from morning to evening.

The experience thus gained was used when the question of ventilating the Baker street and Waterloo Railway was raised; and after carefully considering all the possible ways, and the means at hand for a commercial and workable plant, a compromise was eventually adopted by Mr. J. R. Chapman, the chief engineer of the Underground Railways Company, which is as follows: If at every station of a tube railway, air be forced in from, or taken out to, the surface by means of a closed duct to or from a point situated on the tunnel platform at an appreciable distance from the physical opening of that platform through the passageways and shafts to the surface, then it is evident that this distance will be partly filled by fresh air in the first instance, or plenum method, the existing air being replaced by the air forced in, and in the second instance the existing air being taken out and replaced by air coming from the surface down the shafts and through the passage openings. In addition, a portion of the tunnel length adjacent to the opening of the closed duct will be similarly affected. Of course, a constant closed circuit of air obtains, and the nearer the duct opening is to the passage openings, the more this actual short-circuiting. If now the trains be run through the stations thus treated, it is evident that horizontal columns of fresh air are thrust into the tunnels from the stations, and further pushed on by subsequent columns actuated by following trains.

The exhaust system was eventually decided upon, the following being the reasons against and for its use: With the exhaust system, the air pulled by a fan from the tunnels, is thrown out by means of the closed duct at the roof of the station building, while the fresh air comes in at the street level, and down the lift and stairway shafts. The objection may be made that this air is polluted by the horses and persons using the streets, and the detritus occasioned by surface travel in general. No doubt this is true to a certain extent, but the surface air of London contains so little of impurities when viewed from the standpoint of allowable pollution as to C O_2, that the objection is not a valid one, and the degree of purity to be attained by taking in air by the plenum system at the roof is not appreciably greater, because of closer proximity to the innumerable chimney pots. The great aim is that the movement of the fresh air is down the passageways, and therefore assists the movement given by the trains to a horizontal column of fresh air, and even adding to it by the injector principle, at the same time preventing the train from pushing fresh air up the passageways. If, on the other hand, the plenum system were adopted, and the air taken out by the passageways, there is no doubt that the trains would push a lot of the newly supplied air up the passageways. Of course, this argument is applicable only to the scheme as laid out.

Figs. 1 and 2 which show the arrangement at Waterloo station, illustrate the above features. If, then, it be conceded that at every station a supply of fresh air is available for the use of movement by the trains, it may be safely asserted that no small proportion of this fresh air will find its way into the tunnels between the stations, and into the carriages when the trains are opened at the stations. To make certain that sufficient air may be available, each fan has been designed to exhaust 1,000,000 cubic feet of air per hour—sufficient to renew all the air

in the average length between the stations in both tunnels every thirty minutes. In addition, the path of suction being a relatively short one, and the area of the duct varying between 12 and 16 square feet (Fig. 3), no great water-gage and velocity are required, and the efficiency is relatively high. At Waterloo, where the test was made, the ducts are longer and have more bends than at the majority of the stations, and consequently the results attained was less favorable than the average. In fact, the water-gage was raised 0.25 inch above the normal, and consequently the necessary horse-power was increased.

Test of fan at Waterloo station, October 17, 1905:

Volts at motor terminal	557
Amperes at motor terminal	12
Electrical horse-power at motor	8.95
Revolutions per minute of fan	242
Water-gage at fan inlet in inches	1.2
Cubic feet of air passed per minute	18250
Horse-power hours per 1,000,000 cubic ft per hour	8.1

Note: The cubic feet of air were measured by passing an anemometer over the entire surface of the opening under the platform, measuring 13.25 square feet surface. At this point the mean velocity of air was 1377 feet per minute.

As a check, the anemometer was held in five different positions in the fan inlet for a total length of time of approximately 30 minutes, when the average velocity obtained was 1290 feet per minute, which multiplied by the area of the intake—14.5 square feet—gives 18,700 cubic feet per minute. The water-gage was measured with a U tube connected with an air duct, as shown in Fig. 5.

To obtain these results the following points were observed: The fan was increased in size above that usually employed for the volume of air to be handled and the water-gage necessary. This resulted in a comparatively low speed, and a solidity of wheel and moving parts. Concurrently the fan-housing was made large, so as to leave a large area between the wheel and the housing. Finally, the motor was carried on a separate bed-plate and concrete foundation, and the wheel was over-hung from this bed-plate, the result being that absolutely no moving parts are attached in any way to the housing or air ducts, and consequently there is no tendency to set up vibration and produce a sounding board effect. Figs. 4, 6 and 7, giving details of the fan, will clearly show the construction.

In how far the desired results have been attained, can be judged from the preceding figures of tests made at Waterloo station, but the final success of the system cannot be assured until trains have been run in service for a sufficient length of time, and carrying passengers in sufficient numbers to insure the possible pollution of the air in the tunnels were it not efficiently renewed."

Wooden Ties

THE work of the Maintenance of Way Association on the numerous phases of the tie question, has brought the wooden tie to the point where but little more can be done to prolong its life as far as chemical treatment is concerned, and attention has now been given to a feature that heretofore received but little consideration, namely, standardizing the dimensions of the tie and also the number per rail for three types of track-ballasted track for heavy traffic; ballasted track for light traffic and unballasted track, that is, to produce a standard for the specific conditions noted and their corresponding rail weights, the tie mentioned for this purpose being 7 inches by 8 inches by 8 feet.

In the discussion objection was made to the adoption of the standard as given above, on the ground of the increased cost, while it was recognized that the cost should be increased for heavier equipment. The opinion was expressed also that ties 7 inches by 10 inches by 8 feet 6 inches were not too large, and which were already in use, and again, a member could not see why there should be a standard tie any more than a standard weight of rail. The reasons leading up to the stand taken for increased dimensions and improved spacing are well sustained by the necessity of taking cars of the increasing tonnage as well as the character of soil under the rails, and indicates the close attention given to correct track conditions, but there is a well defined sentiment among many maintenance of way officers that the time is past when further improvement of the wooden can be considered with profit, since its cost is steadily increasing, due to the growing scarcity of the proper size of timber. There is no doubt of the benefits accruing to standardization, but there is a belief strongly materializing among well-informed track men that attention given to the perfection of the steel tie would be more for the permanent good of track construction than can further consideration of wood for that purpose. The mechanical requirements of a metal tie have already been met, and it only remains for the cost to be brought to a reasonable figure to force attention to its value as a substitute for the wooden tie.

Reinforced Concrete Arches, C. R. R. of N. J.

CONCRETE arches have been the order on the Central Railroad of New Jersey for some time, and have therefore received the closest attention in those features referring especially to reinforcement. Two of the most recent examples of double track construction in this line are illustrated herewith, one of which is an arch at right angles with the tracks, and the other is of the skew type, while both have elliptic arches.

The skew arch as shown in Fig. 1 is located in Newark, N. J., over Jackson street, and has a span of 54 feet 3 inches, with a clear height of 17 feet under the crown, the thickness of which is 30 inches. Being located at tidewater, and on filled ground, the character of the foundation necessitated considerable piling which was driven at 2 feet 6 inches centers and filled between to a depth of 3 feet with broken stone. Above the piles is two rows of expanded metal which carries the concrete superstructure of the arch and the coarse fill outside of the latter, which in turn supports the cinder and stone

ballast, the latter being contained between the parapets at either side.

The reinforcement consists of 1¼ inch round steel rods running around the arch, spaced at 6 inches centers at the inner face of the arch, and 12 inches centers at the outer face, located in both cases at a distance of four inches from the outer and inner curves. Transverse steel rods also of 1¼ inches diameter, are staggered over and under these curved rods and spaced at 30 inches centers. The coping on parapets and wing walls is reinforced longitudinally by ¾ inch rods spaced at 6 inches centers.

In Fig. 2 is seen a concrete arch at Vulcanite, N. J., carrying a double track over the street. This arch has 30 feet opening in the clear, with a height of 15 feet under the crown, and a thickness of 20 inches at the same point. There are openings 7 feet wide at each side for foot travel, one of which, and also half of the main arch, shows the construction forms in place, and method of lowering the centres.

The reinforcing of this arch is similiar in principle to the first case noted with reference to the longitudinal rods passing around the arch. These rods are 1 1-16 inches diameter, spaced 12 inches centers at the top of the arch, and 6 inches centers at the bottom line, while the transverse rods are placed inside of these at 3 feet centers. In addition to these rods there are others placed vertically, of ⅜ inch diameter and spaced at 3 feet centers, and still others of 1¼ inches diameter placed diagonally at the spring line of the arch. As in the case of Fig. 1 this arch rests on expanded metal.

It will be noted that the construction of these arches is in accord with the best practice for structures of the kind, which are now being so extensively used in railway practice to the exclusion of stone, brick, or a combination of both. We are indebted to Chief Engineer Osgood of the Central of New Jersey for the prints from which these illustrations are made.

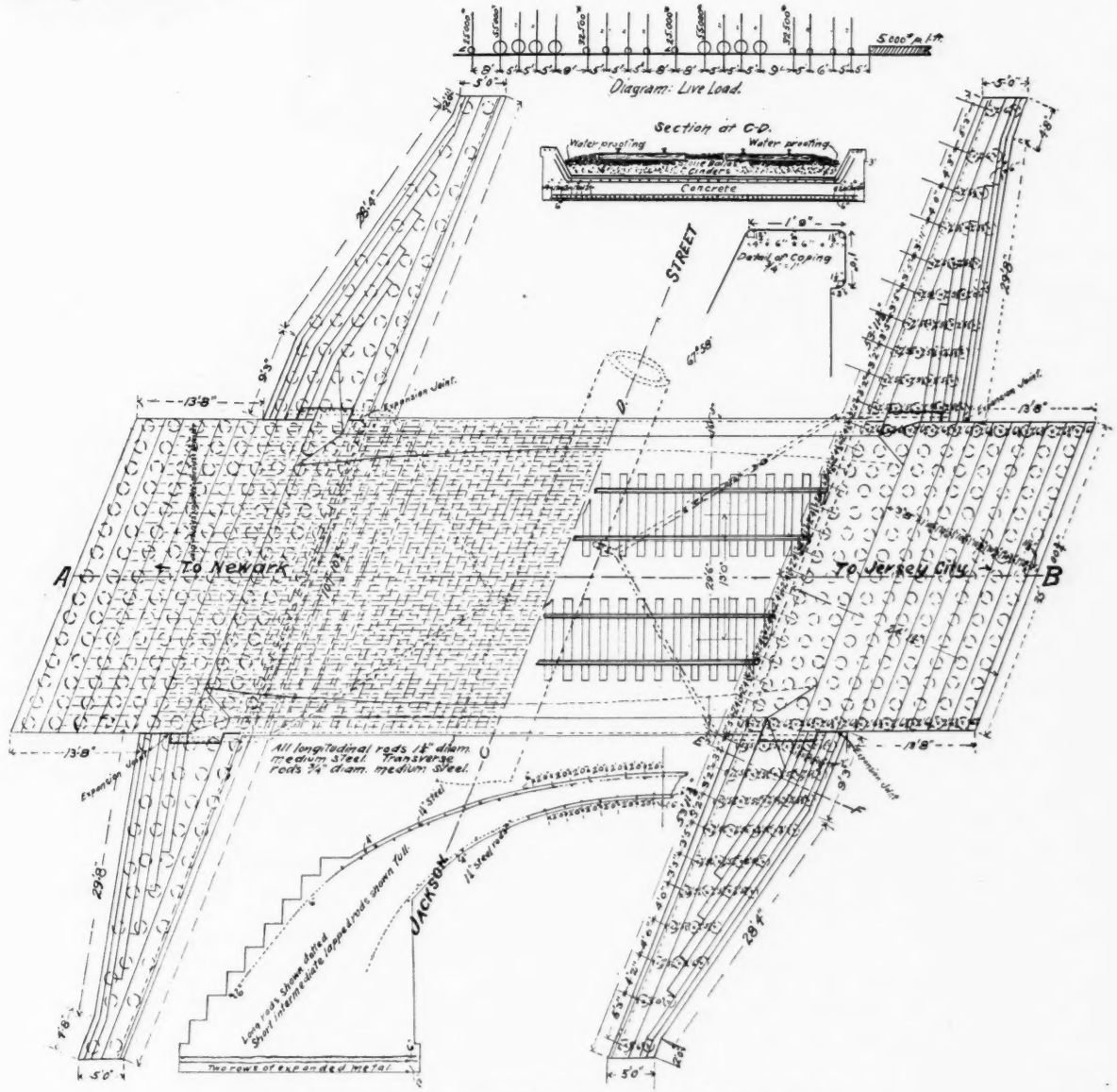


FIG. 1—FOUNDATION PLAN, REINFORCED CONCRETE ARCHES, C. R. R. OF N. J.

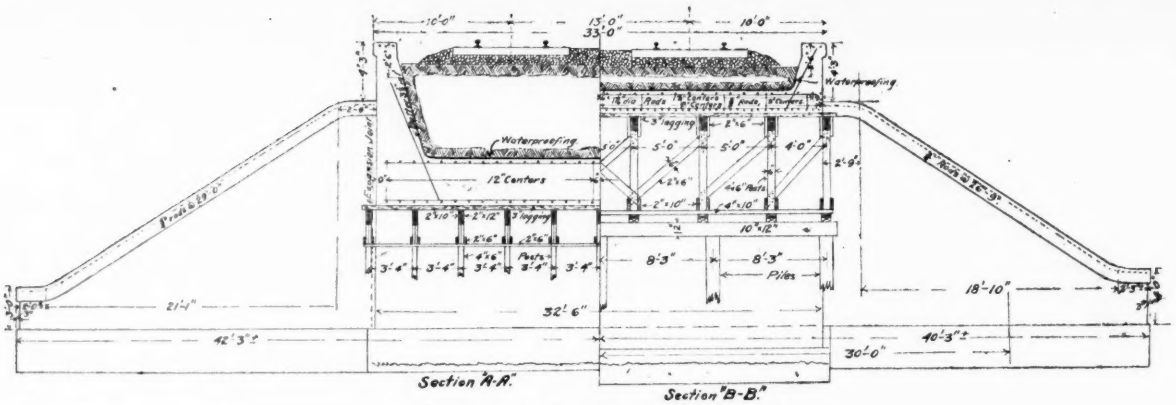


FIG. 2—TRANSVERSE SECTON OF CONCRETE ARCH.

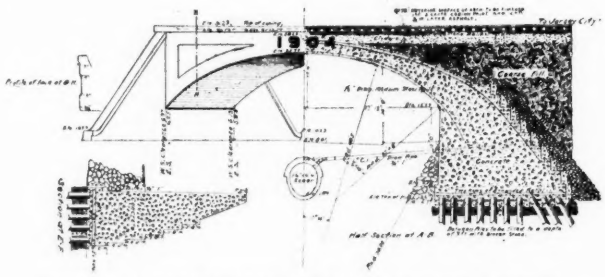


FIG. 2—HALF SIDE ELEVATION AND HALF LONGITUDINAL SECTION.

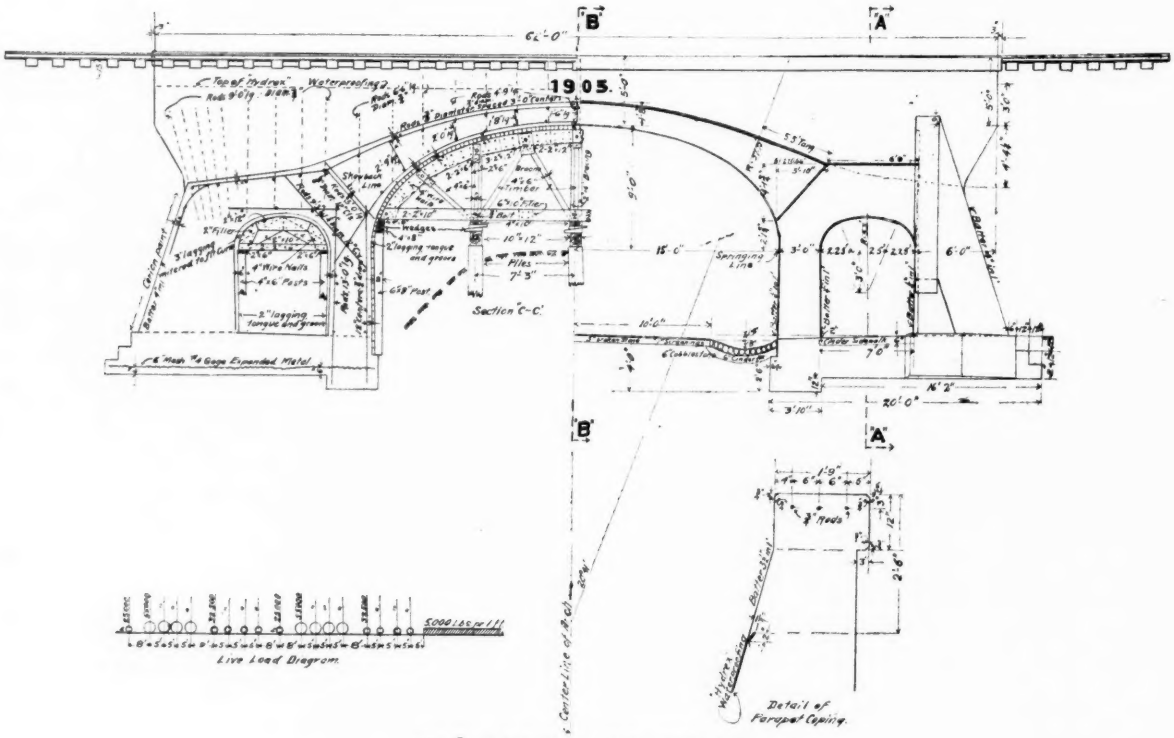


FIG. 2—FALSE WORK AND FINISHED ARCH.

The Steel Tie

AN evidence of the attention given to the steel tie question is to be noted in the quiet installation of it for experimental purposes. These moves are not heralded abroad—in fact the trend is in the opposite direction, but sufficient information is gathered to indicate the interest taken in means to forestall the time when the price of wood becomes prohibitive for tie purposes. The steel ties put in within less than two years—and they now number nearly or quite 200,000—are laying the foundation for further tie practice. The proposition is simply one of finding a substitute for wood, and the experiments under way are now of such magnitude as to lead up to that result.

The life of the steel tie is a mooted question and the uncertainity of it, strangely enough, has no bearing in the case, since it is believed to embrace a period anywhere from 30 to 100 years, and this leaves a margin that should be negligible for comparison with wood. It is plain that while length of service is one of the most vital factors in the selection of steel for this purpose, there are other and what perhaps will be controlling factors, which include the matters of design and cost, for the design must be such as gives an elasticity closely approximating that of wood, a feature that is one of the strongest arguments in favor of the wooden tie, and after that is accomplished the price must be such as to encourage its use, even though the cost of maintenance is thought by its sponsers to be an infinitesimal quantity.

Several designs of steel ties are represented in the equipment now on trial, among which are those of I-section, some of channel section and some of box section all of which are rolled or pressed to shape. The service given by these ties under heavy traffic is being closely scrutinized with the view of improvement in design on the first indication of weak points, and advantage is also being taken of the opportunity to note the effects of rigidity on both rail and tie, for that element is expected to determine to a large extent the use of these ties. With such data it will not be difficult to choose between inherent elasticity and the applied article to produce the same in the form of a yielding agent between the tie and rail, which has been put in on some foreign roads. The practical information following these experiments on trunk lines, is what is needed to get a correct line on the steel tie, and should give data that will aid in the design of a metal substitute for wood.

Design of Reinforced Concrete Beams

IN the short time in which reinforced concrete has demonstrated its fitness for structural work, the designers of composite beams have been a law unto themselves in the distribution of steel, with the result that various methods of reinforcement are found, many of which it may be said do not reflect a high order of engineering ability, or even an elementary knowledge of the resisting moments of materials. The importance of the subject in its application to engineering problems made the need of a reliable authority on design a most pressing one, and this has been recognized by a valuable work covering this phase of concrete construction, from which an extract is made to illustrate the rational method employed by the author* in the design of reinforced concrete beams, as follows:

It has been stated that the steel section was so designed as to be protected by one inch of concrete at the center of the span. This was fixed at one inch by balancing up two important factors, each directly opposed to the other. For instance, to render the beam or girder fire resisting, it is well to have the steel members thoroughly protected from below by concrete, which tends to have the tension members approach the neutral axis. On the other hand, in order to obtain the greatest moment of resistance in tension, the tendency is to have the tension members approach the underside of the beam or girder. Along this same reasoning, in order to prevent hair cracks, caused by excessive tension due to deflection, across the underside of the beam which, although they do not to any extent affect the strength of the beam, are very unsightly, the tendency is to have the tension members approach the underside of the beam, since this adds to the stiffness of the beam and thereby lessens the tension in the concrete below the steel. By equating these factors, judgment will fix the location, especially at the center of the span, about one inch from the underside of the tension members to the underside of the beam or girder.

Finally, to give an outline how the values (in which I=moment of inertia, and V=distance to the neutral axis), and the safe allowable resisting moments both of comparison and tension, were deduced, the following routine is given:

Let M=Maximum bending moment.

b=Width of beam or a width of floor corresponding to bending moment above.

d=Width of beam or thickness of floor down to center of tension members.

Then $\frac{M}{500} = \frac{I\,b\,d^2}{4\,d}$ whence assuming b, d is computed. This is a preliminary step, but after the neutral axis is located, and using the value of d just found, the fiber stress at top fiber figures about 850 pounds per square inch. Calling the ultimate compressive stress 3,000 pounds per square inch, which should be attained in a 1-2-4 or a 1-1½-3 mixture, the stress just found gives a factor of safety of three and one-half.

The next step is to find the area of steel which, when taking all the stress in the worst position of tension, takes a stress of 15,000 pounds per square inch. This is figuring a factor of safety of 3.5, with an ultimate stress of 53,000 pounds. To do this, I assume the neutral axis to be from 1.5 to 2.0 inches below the center of gravity, and figure the center of gravity thus:

$$\frac{M}{15000} = \frac{a\,h^2}{h}$$

Where a=area of steel.

Where h=distance from center line of steel to neutral axis assumed above.

With this area of steel, the neutral axis can be located

*Reinforced Concrete, by F. D. Warren, Massachusetts Institute of Technology.—D. Van Nostrand, New York.

by taking moments, after transposing the area of steel into area of concrete (with reference to the modulii of elasticity of the materials) as stated. If this location does not come sufficiently near to 1.5 or 2.0 inches below the center of gravity of the section to fulfil the assumption previously made, use this value to determine h in the last formula.

(Namely $\frac{M}{15000} = ah$), and solve again.

This value of a will probably not change the location of the neutral axis found previously, enough to affect results. Now we are able to figure the fiber stress of the concrete in compression and so check the 850 pounds per square inch with the sizes we have determined, or else fix new sizes to give more than 850 pounds per square inch for the concrete in compression.

Preparation and Painting of Steel Structures

By W. T. Hogan, Ex-Master Painter

Having read many articles upon the subject of paint for the protection of iron and steel cars, structural iron work, etc., through your magazine and others, prompted me to say a few words upon the subject, modestly submitted through your valuable columns. Judging from the articles heretofore noted upon this subject, it is very generally admitted that the paints on the market especially intended for iron and steel surfaces, are not wholly satisfactory to the trade. I will endeavor to show the causes underlying the existing dissatisfaction based on long experience and many tests of various combinations of pigments and oil and to indicate how they can be successfully and practically removed.

I will first deal with the subject of "Rust" as it is the one great evil the paint fraternity have to deal with, particularly so when we take into consideration the cost of structural iron work in large buildings and that of the iron and steel cars, their maintenance depends largely upon checking rust. To intelligently solve this problem, it is quite necessary to first look into the conditions iron and steel are subjected to, for instance, when painting structural iron work for buildings and that of the iron and steel cars, while the iron is practically the same, there are some few different conditions paint has to contend with. Paints must be made for their respective places. The former, dampness practically the year around and much greater during the breaking up of the winter, of walls sweating out badly.

The iron and steel cars having more or less moisture to contend with is not enclosed, in other words, sandwiched in between damp walls and hidden from sunlight like that of the structural iron work, moisture does not get the same chance to lay upon cars like that of structural iron work. Again, when buildings are completed there is no possible chance of ever doing anything with them in the way of checking rust. The result is eating away, slowly but steadiy the steel foundations. For protection of iron and steel structures subjected to above conditions, there is practically but one condition paint has to contend with, and that is moisture; paint must be of a nature wholly antagonistic to moisture.

The condition of the iron and steel cars in addition to being subjected to moisture, must also be of a nature to offset intense heat and extreme cold which produces expansion and contraction. Again, these cars are loaded with hot mill slag and much more severe upon painted surfaces than either of above conditions, and while a few of the many paints on the market sold for the protection of iron and steel surfaces have produced only ordinary results, when applied upon the car subjected to artificial heat, in addition to the other conditions, its life is only of short duration and the manufacturer wonders at the results, particularly so, when he calls your attention to the elastic properties, when being dried out and to the sense of touch with some degree of pressure is very tough, elastic-like and firm. However, I dare say, had the manufacturer taken more seriously under consideration the elastic properties in the manipulation of a mixture for the latter condition, he would have met better results, for an elastic property that will produce fair results in ordinary paint to offset heat and cold and the same mixture proved a failure upon the surface subjected to artificial heat brought about from hot mill slag.

There is only one conclusion and that is, the elastic properties contained in paint were too sensitive to artificial heat.

Paint to fulfill its many function must have many certain and reliable qualities, but cannot be put upon the market and compete with many of the conglomerations of various pigments and worthless oils now on the market and labeled some fancy name for the protection of iron surfaces, all of which have been found wanting, among them a few with an odor to deceive the consumer or purchasers of its true nature that would put a dog to flight.

Referring back to the question of "Rust," I have heard it said time and again among paint manufacturers, civil engineers and painters, who claim it is quite necessary not only to remove rust from the surface, but stoutly adhere to the idea that it is quite necessary that rust must be removed from the pores of the iron and steel to remove same from the surface in order to aid paint in checking rust.

With all due respect to their opinions this, in my estimation, is the one great mistake of today in trying to check rust. Rust in pores of iron is what you want and where you want it, and if rust in pores of iron does not show itself, the writer always brought it about with what he terms a liquid rust producer absolutely free from chemicals of any kind.

Rust is hydrated oxide of iron, in other words, a powdered oxide, and I might add a peroxide paint in dry form, it cannot be entirely banished as claimed by many writers on this subject. Then I suggest, why not use it in this condition upon iron and steel while in its infancy and in dry powdered paint form.

After iron and steel have been cleaned of rust and scales, this is usually effected by means of a sand-blast, there are other methods, but none so clean, quick and economical. However, the real object of the writer advocating the use of the sand-blast in preference to other methods is not so much to remove ordinary rust from surface as it is to destroy enamel or smooth finish upon iron and steel surfaces, at the same time enlarging the mouth of pores of iron and steel enabling paint to adhere firmer than upon a smooth surface. Another advantage gained by the use of the sand-blast, paint can be made more elastic for a surface of this description and adhere better than that of a smooth one, insuring greater durability.

Right here, gentlemen, is where you check rust and the only opportunity afforded during the process of painting iron and steel surfaces. As heretofore stated, the one mistake of today is trying to check rust with various pigments of all descriptions made up into different combinations and applied for the protection of iron and steel. Let us see what the results are, particularly among the cheaper combinations. To start with, pores of iron and steel are full of air, is it natural to suppose that during the application of paint being spread over the surface it has driven the air from the pores? Not at all. On the contrary, no matter how fine your paint has been ground or how thoroughly it may be whipped out and laid off with a light touch of the brush, it will bind and bridge over face of pores, at the same time enclosing more or less moisture in pores, and any ordinary vibration or expansion and contraction will break them and admit more moisture. What is the natural consequence? Is it not natural to suppose that corrosion starts in almost immediately in a mild form and, as time advances, increases in rapidity, subsequent coats of paints upon priming coat does not, or cannot, in the least, aid any in checking iron, as many suppose. The more inferior the protective coats, the

speedier oxidation sets in and the quicker rust shows itself upon the surface. However, in the meantime, rust is doing its deviltry upon iron and steel just the same as if subsequent coats of paint upon priming coat were not there. Nothing, practically speaking, has been accomplished in the way of checking rust upon iron and steel, more than subsequent coats of paint upon primer has hidden the evil existing from the start, but in a short time shows itself upon the surface.

Now the question would naturally arise as to what I would deem the best paint for iron and steel surfaces. Answer—a chemically pure peroxide for several reasons, a few I will mention later on.

Oxide paints are as numerous as the hills, but 95 per cent of them do not contain over 55 per cent peroxide of iron; the balance is made up of selicious matter and roasted earth, both of which have in their composition more or less sulphur and phosphorous, alike destructive to linseed oil and most susceptible to moisture. Many on this account are prejudiced against peroxide paints without having ascertained by chemical analysis whether they are chemically pure or not.

A good paint as a preserver should have a good covering power, and a pure peroxide cannot be questioned on that score, but selicious matter and roasted earth do not possess any such covering power.

Among the many paints used for the protection of iron and steel, I believe red lead is the most popular, more particularly on account of its drying qualities, it is more a subject of deception and adulteration than pure oxides. Red lead in its pure state has not the affinity or chemical attraction for linseed oil found in pure oxide. Great care must be exercised in mixing it with linseed oil, and that only in small quantities at a time and during the application it must be kept thoroughly agitated, otherwise it will separate from the oil and precipitate to the bottom of the vessel. Graphite is slightly of a similar nature and many combinations of asphaltum, coal tar and ordinary minerals; altogether, I have found no comparison to a natural product of practically a pure peroxide of iron, especially so where each coat of peroxide paint is made and designated for its individual place in the painting of iron and steel surfaces and is so used.

After iron and steel have been cleaned as herein mentioned, I reproduce rust with what the writer terms a liquid rust producer, going over surface freely using sponge or paint brush giving particular attention to corners and rivets. Sponge off fairly dry and let stand one to two hours; at the expiration of this time, you will observe more or less rust in pores of iron in powdered form "dry."

This condition of iron and steel, gentlemen, is in excellent condition to hermetically seal the pores and check any further rust, and the only opportunity afforded during the process of painting iron and steel.

A priming composition suitable for iron in this condition must be penetrating, elastic, adhesive and neutral to iron and steel. The former qualification immediately upon application reaches the depth of pores driving air to the surface, loosens the rust or powdered oxide in pores and utilizes it, showing the utmost affinity between rust and primer, practically sealing the pores and establishing a thorough foundation for subsequent coats of paint.

The rust of powdered oxide in pores forming the indestructible pigment.

A primer of this description must not be sand papered for such procedure would immediately open the mouth of pores and undo the object in view.

Second coat should be of a similar nature to that of primer, more than it is the nature of paint having a slight deviation in elasticity, the pigment in same being of a chemically pure peroxide.

Third coat should slightly resemble the second coat except as to elasticity, when dried out it should not contain a gloss but slightly higher than that of an egg shell. Now I do not wish to convey the idea that this can be brought about by linseed oil in its natural state and produce the desired satisfaction.

Both coats, second and third, should be ground fairly fine. This will cost a trifle more, but never mind the cost. The extra covering and preserving power derived from a paint of this kind will more than offset the cost of grinding, particularly the second coat, as it will enter the mouth of the pores and unite solidly with the priming composition affording a more solid protection against moisture.

The coarser the mechanical division of paint the less adhesive and tenacious, the larger the pores and the greater the absorbing qualities for moisture and the speedier oxidation sets in.

First and second coats of paint should be made for their individual place in the painting of iron surfaces as already stated. What I refer to by each having its individual place in the painting of structural iron work and the iron and steel car is this: It is absolutely essential that there should and must be some slight deviation in elasticity in order that each individual coat may adhere firmly to the other (building out) whereas, if each coat be of a like nature in elasticity they do not have that affinity for one another and will lay upon each other closely, as for instance, three or more sheets of paper would do under a pressure; but with the proper variation in elasticity, harmony is created among the coats applied and form almost a perfect blend, having so thoroughly amalgamated together that they may be compared to so many pieces of iron welded together so as to practically form but one coat of paint and yet yield readily to expansion and contraction. The results you will find, in a coating upon iron and steel that is surprisingly durable.

The method summed up briefly is as follows:

First, study the conditions iron and steel are to be subjected to, and make paint to meet the conditions, including bridges, old or new, steel water tanks, etc.

Second, sand-blast upon large bodies, object is not so much to remove ordinary rust from surface, as it is to remove enamel or smooth finish upon iron and steel. It also enlarges the mouth of the pores, both assisting paint to adhere firmer than upon a smooth surface. Another great advantage gained is, paint can be made more elastic, insuring greater durability.

Third, produce rust.

Fourth, liquid primer must be of a penetrating and elastic nature capable of utilizing all powdered oxide in pores, the oxide forming the indestructible pigment.

Fifth, a chemically pure peroxide, especially so when following liquid primer; its preference over red lead, graphite, asphaltum, coal tar and numerous other paints is owing to its being of a natural product and neutral to iron and steel.

Sixth, while the wearing properties in painter material is linseed oil, it has its place in the manipulating of the different coats applied, and when used out of place is a detriment.

Seventh, a pigment entering into the composition is relatively equal in importance with that of oil.

Eighth, a priming composition holds the same relative position in painting as does the foundation to that of a building. If you must economize, do it on subsequent coats, for you may have the job to do over and you will have something to work on and help to get you out of your predicament.

Ninth, avoid heavy coats of paint. If the degree of durability depended upon the quantity of paint, liberality in its application would be commendable. Paint thrown on carelessly lays upon the metal in a thick, heavy mass and the atmosphere in a short time absorbes its life and it flakes and peals off.

Tenth, an inferior paint, properly applied, causes usually less disastrous results than would a superior article improperly manipulated and carelessly used. A man may be very proficient owing to constant practice in the application of paints and yet he may be quite unfamiliar with the ingredients entering into the composition to meet, or offset certain conditions.

Personal Mention

Mr. William Bollons has been appointed district engineer of the Southern Pacific at Portland, Ore.

Mr. J. S. Kunkel has been appointed resident engineer of the Mexican Central at Manzillo, Mex.

John Walsh, supervisor of track of the Rutland at Malone, N. Y., died on April 16 at the age of 45 years.

Mr. W. B. Chapin has resigned as chief engineer of the Central New England, and is now located at Tonopah, Nev.

Mr. E. K. Large has been appointed assistant supervisor of the Philadelphia division of the Pennsylvania at Harrisburg, Pa.

Mr. T. C. Bowen of Marion, O., has been appointed chief engineer of the Lima & Eastern, projected from Lima to Marion, Ohio.

Mr. George H. Burgess has been appointed engineer of terminal improvements of the Erie, with office at No. 11 Broadway, New York.

Mr. D. L. Stewart, division superintendent of bridges and buildings of the Delaware, Lackawanna & Western at Bath, N. Y., has resigned.

James H. Linsley, formerly for 35 years division roadmaster of the Chicago, Burlington & Quincy, died at Galesburg, Ill., on May 4, aged 83 years.

Mr. W. H. Kirkbride, heretofore roadmaster of the Southern Pacific at Red Bluff, Cal., has been appointed assistant resident engineer at Sacramento, Cal.

Mr. W. C. Armstrong has been appointed bridge engineer of the Rock Island Lines, with office at Chicago, vice Mr. A. D. Page, promoted; effective on April 9.

Mr. A. C. Hezlep has resigned as engineer of maintenance of way of the Wabash Lines east of Toledo, with headquarters at Canton, O., to engage in other business.

Mr. R. S. Blinn, formerly locating engineer of the Illinois Central, has been appointed chief engineer of the Mariette & Lake, with headquarters at Freeport, O.

Mr. D. Sheahan has been appointed inspector of maintenance of way of the Southern district of the St. Louis, Iron Mountain & Southern, with headquarters at Little Rock, Ark.

Mr. E. H. Barnes, heretofore resident engineer of the Grand Rapids & Indiana, has been appointed chief engineer, with headquarters at Grand Rapids, Mich., effective on April 9.

Mr. A. W. Jones has been appointed assistant engineer of the White River division of the Missouri Pacific at Crane, Mo. He will also have charge of the construction of the Springfield Southwestern Railway.

Mr. R. E. Merrick has been appointed chief engineer of the Pacific & Idaho Northern, with office at Weiser, Idaho. Mr. Merrick was formerly connected with the Buda Foundry & Manufacturing Company of Chicago.

Mr. William H. Bush has been appointed chief engineer of the Central Railroad of Louisiana, in charge of construction, with headquarters at New Iberia, La. Mr. Bush heretofore has been assistant engineer of the Kansas City Southern at Pittsburg, Kan.

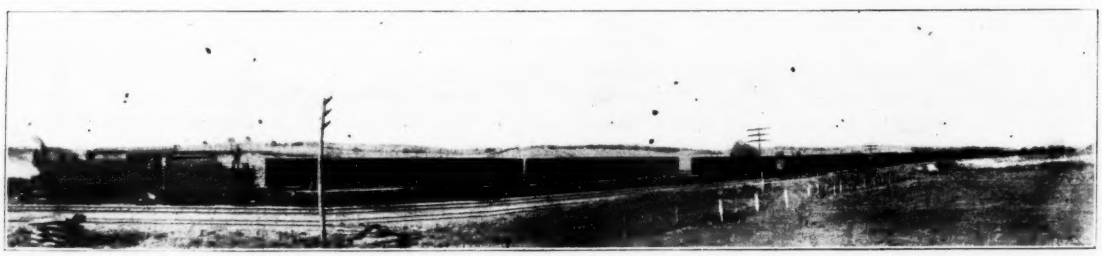
Mr. C. H. Rickey has been appointed supervisor of the Pennsylvania at Oil City, Pa., in place of F. C. Shipman, deceased. Mr. A. G. Follette has been appointed assistant supervisor of division No. 10 of the Pittsburg division, to succeed Mr. Rickey.

Mr. N. W. Smith,, heretofore supervisor of the Pennsylvania at Altoona, Pa, has been appointed assistant to the principal assistant engineer of the Pennsylvania Railroad division, with office at Altoona, vice Mr. F. T. Hepburn, resigned, effective on May 1.

Mr. Harry Hartwell, who has been connected with the engineering department of the Nashville Railway & Light Company of Nashville, Tenn., has been appointed assistant chief engineer in charge of maintenance of way, of the United Railroads of San Francisco.

Mr. Grant Flora, roadmaster of the Chicago, Rock Island & Pacific at Estherville, Ia., has been transferred to Iowa Falls, Ia., in a similar capacity, succeeding Mr. John McNulty, who has been appointed roadmaster at Nora Springs, Ia., in place of Mr. J. Kiley, resigned.

Mr. F. H. Bainbridge has been appointed engineer of the Pierre & Fort Pierre Bridge Railway Company, which is building the bridge over the Missouri River at Pierre, S. D., for the extension of the Chicago & Northwestern to Rapid City, S. D. Mr. Bainbridge heretofore has been assistant chief engineer of the Chicago & Northwestern at Chicago.



A MONSTER SHIPMENT OF PLATE GIRDERS

Mr. A. S. Zinn, assistant engineer on track elevation for the Chicago & Western Indiana at Chicago, has resigned to accept a position as engineer of construction of the Michigan Central, in charge of double track work, with headquarters at Saint Thomas, Ont. Mr. Zinn was formerly principal assistant engineer of the Chicago, Rock Island & Pacific.

Mr. P. A. McCarthy, senior member of the engineering firm of McCarthy, Starnes & Co., consulting engineers, Lufkin, Tex., has been appointed chief engineer of the North & South Texas Railway, which proposes to build a standard gauge steam railway between Lufkin and Groveton, Tex., and which is to be extended south later. His headquarters will be at Lufkin and Groveton, Tex.

Mr. B A Cunningham has been appointed resident engineer of the New York Central & Hudson River in charge of Gardenville yard improvement at Buffalo and double tracking and grade revision on the West Shore west of Syracuse, N. Y., with headquarters at Buffalo, N. Y. Mr. C. L. Spaulding, heretofore assistant engineer at Schenectady, N Y., has been appointed resident engineer at that point to succeed Mr. Cunningham.

Mr. A. S. Hecker has resigned as assistant engineer of the Wabash at Pittsburg, Pa. Mr. A. R Briggs, heretofore assistant engineer of maintenance of way of the lines east of Toledo, has been appointed engineer of maintenance of way of those lines, with office at Canton, O., succeeding Mr. A. C. Hezlep, resigned. Mr. C. S. Lambie has resigned as assistant engineer at Pitts-

burg. Mr. L. J. Leighty has resigned as general foreman of carpenter gangs at Canton, O.

Mr. P. H. Ashmead, formerly engineer in chief of the Canton-Hankow Railway for the America China Development Company, has received a special appointment by J. G. White & Co., New York, in connection with the Philippine railroad development projected by that company. For the present he will act as representative for Edward J. Beard, chief engineer of the Philippine railways in the field. Mr. Ashmead was for several years associated with railroad development in South America and has had an experience that peculiarly fits him for his present work. Among the engineers already engaged by J. G. White & Co. and now on their way to the Philippines are Mr. H. F. Howe, recently acting chief engineer, and Mr. C. H. Farnham, division engineer and superintendent of construction of the San Shui division, both of the Canton-Hankow Railway; Mr. J. M. Robinson, formerly locating engineer of the Guayaquil & Quito Railroad; Mr. L. E. Bennett, previously engineer to the emperor of Siam for railways and irrigation and more recently assistant to Secretary Taft in outlining the transportation plans of the government in the Philippines, which are now being put into execution; also Mr. C. J. Hogue, late superintendent of maintenance of way on the Chektaw division of the Rock Island; Mr. F. D. Nash, recently in charge of 50 miles of reconstruction on the Burlington System, and Mr. C. H. Hill, of the Michigan Central.

A Monster Shipment of Plate Girders

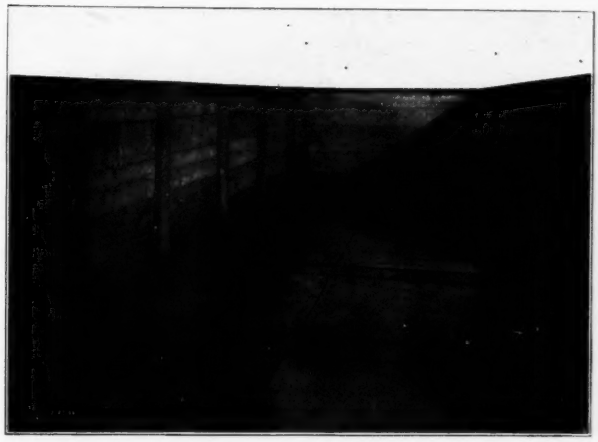
The largest single shipment of plate girder bridges ever made was run as a through train from the Pittsburg plant of the McClintic-Marshall Construction Co., who built them, to Freemont, Neb. The girders were built for the Platte River bridge on the Burlington lines of the Great Northern Ry. The girders were all 72 foot lengths. We are indebted to Mr. R. W. Knight, Contracting Engineer with the above company, for the accompanying photograph.

Railway hand cars of today must be strong with the least possible weight, for while they may not possibly carry any greater loads today than previously, trackmen encounter faster trains and more traffic and demand a car that can be easily removed from the track. The pressed steel wheels and general design of the car made by the Buda Foundry and Manufacturing Company fill the requirements and the increased demand for their cars needs no explanation as to their practicability. Catalogue furnished on request by The Buda Foundry & Mfg Co., Ry. Exchange, Chicago.

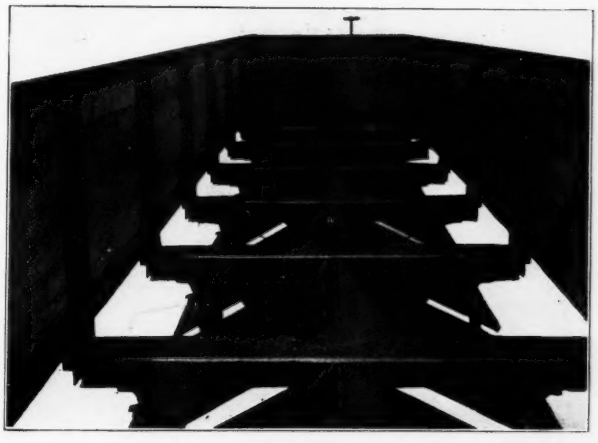
Among the later publications, "Yards and Terminals and Their Operation," issued by the Railroad Gazette, New York, deserves special mention. It is the result of a long and varied experience in this line and is the work of J. O. Droege, Div. Supt. N. Y., N. H. & H. The table of contents takes up the following subjects: Relative Importance of Terminals, Terms and Definitions, General Principles of Design, Designing Terminals, Track, Ash Tracks, Coaling Plants, Icing Plants, Switching Methods, Pole Switching, Summit Switching, Gravity Switching, Records, Management and Discipline, The Yardmaster, Loading Cars, Making up Trains, Fast Freight, Freight Houses, Freight Piers and Coal Piers. An extract from the chapter on Management and Discipline reads as follows: "The men employed by a railroad are usually wide scattered and most of them are not under the direct supervision of an officer. Even the conductor of a train cannot always keep the members of his crew in sight. It is essential, therefore, that every man from the lowest to the highest be impressed with the necessity of doing everything that he should do and nothing that he should not do. Every employee should be made to feel that explicit confidence is reposed in him."

Ralston Steel Frame Combination Car

The need of a dump car that would easily and rapidly unload coal, ashes, ore, sand and like material was the cause of the development and designing of the rather unique type of car that is known as the "H-5 Standard Flush Floor Drop Bottom Car." This type of car was first built with 12 doors arranged



CAR READY TO LOAD.



CAR READY TO UNLOAD.

in the floor between the bolsters. This car dumped about 85 per cent. of the load satisfactorily, but the fact that the remainder had to be shoveled was somewhat detrimental to the sale of the car, and as a result the present type with 16 doors the additional four being placed between bolsters and end sills, was developed.

This car when unloading coal or dry sand, ashes or ore, dumps fully 99 per cent. of the load, and with wet sand, ore, etc., dumps over 95 per cent. The difference being due to the fact that there is a tendency for the wet material to stick to the doors.

The accompanying cuts show car with all doors dropped and again in position for loading. This car is manufactured by the Ralston Steel Car Co., Columbus, Ohio.

Much difficulty is generally experienced in getting paint to adhere firmly to galvanized iron, and various experiments are resorted to to overcome the trouble. The government has adopted a mode of procedure that seems to be satisfactory. Their specifications compel the use of vinegar for washing the surface preparatory to painting. This roughens or corrodes the surface, and gives the paint better adhesion.

Rail Joints

The history of railway track construction affords some interesting material to the student of track lore when traced from its genesis, dating from the strap rail laid on longitudinal wooden stringers, such being the first form of track in so far as this country is concerned. The standard rail of the T-section has remained unchanged in form since its adoption which came on the retirement of the strap construction, but it has been repeatedly changed in section to provide for the steadily increasing wheel loads, until now, the 100 pound rail is standard for trunk line equipment.

It is curious to note that the necessity for a rail of stability was felt practically at the outset of railway construction, and from the flimsy proportions of the strap rail it was but a few years until the 56 pound rail was in use without having passed through the usual process of evolution from light to heavy sections, and that weight of rail is in use today on a considerable mileage of American roads.

Many attempts have been made to improve the square ended rail joint for the purpose of reducing the battering effect of the wheels on the rail ends, which under the impact of traffic become rounded over. In the plan views of the rail joints illustrated, Fig. 1 is a form that shows the ends of the rails cut at an angle, the intent of which is to distribute the wheel pressure gradually over the opening between rails, and cause the impact to be dissipated on both rails at the instant of passing over the joint, and also eliminate the unpleasant shock experienced in passing over worn ends.

A joint devised on similar lines and having the same object in view, is shown in Fig. 2, in which case however, the angular cut is across the rail head only, beginning just inside of the curve on the head, and extending square with the head from that point to the edge of the flanges.

Fig. 1.

Fig. 2.

Fig. 3.

Another idea having the same purpose in view is seen in Fig. 3, where the rail is shown in twin sections, parted through the vertical center line of the head and flange, the two halves when bolted together forming the complete rail, while the joints may be placed at any distance from each other.

The expected efficiency in this construction, like that in the preceding exhibits, is in the support of the wheel tread, on each section of the rail at the same time, the solid section opposite the joint, presumably relieving the latter from the pounding effects of the wheels. There is no record of the performance of these schemes for making a continuous rail, they being placed in evidence to show what is being done in the direction of improvement of the square ended rail.

A clever advertising poster has just been received from F. W. Bird & Son, makers of Paroid Roofing, East Walpole, Mass. It is a life size reproduction of a thorough bred bull dog and will make a valuable addition to railroad officials' art collection. F. W. Bird & Son are sending it to all railroad officials who ask for it.

The Baltimore & Ohio Railroad is having trouble in getting the intended use out of their new extra large freight and passenger engines. At present Chief Engineer D. D. Carothers finds that along the eastern lines, are many tunnels that will have to be enlarged and bridges strengthened before these engines can be used on the road. An approximate estimate of the cost for such work is over $1,000,000, and will take several years time to complete the changes required.

Announcement is made of the appointment, effective September 1st, of Dr W. K. Hatt, as Professor of Civil Engineering at Purdue University, succeeding Professor W. D. Pence, resigned. Professor Hatt has been identified with Purdue University since 1893. He graduated from the University of New Brunswick in the Arts Course in 1887 and from Cornell University in Civil Engineering in 1891. After filling an instructorship in Civil Engineering at Cornell University, and a professorshp in Civil Engineering at the University of New Brunswick, he was appointed Associate Professor of Civil Engineering at Purdue University in 1893, and afterwards Professor of Applied Mechanics in 1896. Since this time, with the exception of two years leave of absence, he has been in charge of the Department of Applied Mechanics and the Laboratory for Testing Materials of Purdue University. He has had a varied experience in the practice of civil engineering along different lines, particularly in railroad location, construction and maintenance, chiefly on the Intercolonial Railroad of Canada. He served two years as Town Engineer of West Lafayette, Indiana, and since 1903 has been in charge of the Timber Tests of the Forest Service, United States Department of Agriculture. Under his direction a program of investigation was mapped out in 1903 and has since been executed at laboratories established at Yale University, Purdue University, the Universities of California, Washington and Oregon, and in a laboratory at Washington, D. C. That the Purdue Laboratory for Testing Materials may continue to have the benefit of Professor Hatt's direction, its organization is to be incorporated with that of the School of Civil Engineering. Profesor Hatt will also continue to act as Consulting Engineer for the Forest Service, United States Department of Agriculture, Washington, D. C.

Mr. Philip Brown, secretary of legation to Guatemala and Honduras, sends an interesting report concerning the trade of Guatemala, particularly with the United States. A new railroad will soon be completed to Guatemala which is expected to make considerable difference in the trade of that country. It will place the capital within three or four days of New Orleans and, in connection with the Central railroad, complete another interoceanic route: It is expected that this new railroad will be opened in July to the town of Sanarate, a day's journey from the capital, leaving a distance of only 40 miles to be constructed. The United Fruit Company has obtained large tracts of banana land in connection with the railroad concession which should help the enterprise. It is expected that a branch railroad will be built into Salvador, a distance of 100 miles, which doubtless would make Puerto Barrios the principal port for that country as well as Guatemala. The steamship service with Puerto Barrios now is limited owing to lack of trade. It is thought when the railroad is completed that the Ward Line, now running to Cuba, will send their ships to this port and that there will be considerable increase in the shipping from other directions. It now costs more to send freight from New Orleans to Puerto Barrios than it does to send it there from Hamburg. There will be superior wharf facilities at Puerto Barrios, affording a great saving of expense over the San Jose route, where embarkation has to be made in lighters. It is thought that the advantage in the way of cheaper freight rates and direct shipments will help the new port very much. American merchants have not heretofore apparently considered it worth while to cultivate this market. It is hoped that they will do better after the new railroad is completed.